Report of the Sub-Group

on

Demand Side Management and Sustainable Development of the Power Sector

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Sub-Group on Demand Side Management & Sustainable Development of the Power Sector

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1 Introduction

The goal of sustainable development, increasing concerns on environmental pollution, and the continuing gap between supply and demand make it necessary that energy conservation forms an important and integral part of any power development programme. The advent of the WTO (World Trade Organisation) regime has further accentuated the need in this regard. The country has to bring down energy intensity per unit of GDP (gross domestic product) so that goods manufactured here remain competitive. A collective effort on the part of government, manufacturers, financial institutions, and consumers is required in this context.

The sub-group on *Demand Side Management and Sustainable Development of the Power Sector* constituted by the Working Group on Power for the Tenth (2002 - 2007) Five Year Plan has tried to address the issues and concerns in this regard and formulate a strategy for promoting energy conservation with special emphasis on demand side measures. The sub-group was chaired by Dr R K Pachauri, Director General, TERI. The ToR (terms of reference) assigned to the sub-group are given in Annex G.

The sub-group had two sittings and deliberated, inter alia, on the progress made in demand side management during Ninth (1997-2002) Five Year Plan, the potential barriers for promoting energy conservation measures, and the strategies required to overcome these including the legislative and institutional aspects. It also addressed some of the environmental issues, especially those related to ash disposal, in the context of ensuring sustainable development.

2 Importance and relevance of DSM

India is recognized as one of the great potential markets for energy in the coming years with an estimated demand growth rate of 6.3% annually. To assure an adequate supply of electricity to sustain its growth, the present installed capacity needs to be doubled in the next 10 to 15 years. Nearly 100,000 MW (as assessed by the [CEA] Central Electricity Authority) of fresh additional capacity would be required by the year 2012. The future growth will, however, be constrained by the lack of financial resources and, to some extent by growing efforts to limit environmental impacts of energy production and use During 1999/2000, the all-India energy and peak requirement was 480 billion units and 72,669 MW respectively. Against these figures, the energy availability was 451 billion units and peak demand met was 63, 691 MW, which lead to an energy deficit of 6.2% and peak deficit of 12.4% (MoP).

The electricity consumption in domestic, agriculture, and industry sectors account for nearly 83% of the total electricity consumption. The consumption in the domestic sector for the year 2000-01 is about 21%, industry 31%, and agriculture 31% of the total electricity consumption. The sectoral breakdowns are based on metered consumption. The captive generation in the industry is not included in the industrial share, leading to underestimation of the industrial consumption. The consumption in the residential sector is predominantly for lighting and refrigeration. In the commercial sector, electricity is consumed mainly in lighting and space conditioning, while motive power accounts for the single largest end-use consumption in industry. The agriculture sector is dominated by pumping loads and, to some extent, by lighting.

Electric utilities in India have adopted the traditional approach of adding new supply capacities to meet the growing demand for electricity. The utilities have been unable to add commensurate supply capacity primarily due to lack of funds as a result of poor financial performance over the years. Unrenumerative tariffs for certain classes of consumer and inefficient management functioning are said to be the root cause for this bad state of affairs. The private sector is now allowed to set up power plants, but the overall performance of the power sector has been dismal. Sustainable development is also assuming greater importance in view of limited resources and increasing demand and population. Though, the per capita consumption of electricity is quite low, the energy consumption per unit of GDP is higher compared with similar developing economies. India's energy intensity per unit of GDP is 3.7 times that of Japan, 1.4 times that of Asia, and 1.5 times that of US. This indicates that substantial energy gains can be achieved in the end-use sectors through energy conservation. In the WTO regime, countries with high energy intensity may face stiff competition due to high energy input cost.

End-use efficiency improvement and DSM (demand side management) therefore offer new hope to Indian utilities to balance the demand and supply of electricity. Any effort to conserve electricity at the end-use will have a positive impact on the environment as production of electricity has direct bearing on it. With new technological innovations, it is possible to conserve energy by using energy-efficient appliances.

Electricity generation, supply, and use have a considerable impact of on the environment, and, with the increasing prominence of global warming issues worldwide, utilities have to face more and more stringent pollution standards in future. Achieving higher end-use efficiency levels and DSM can avoid economic and social costs associated with power plant construction and operation. If one accounts for such externalities, energy conservation becomes more cost-effective than adding a new supply.

Utilities in the US, Canada, and several European countries are meeting (or saving) part of their new demand through DSM and energy-efficiency measures. A recent study carried out by the US Office of Technology Assessment estimates that overall electricity savings of 50% are possible in developing countries with currently available energy-efficient technologies. Further, these technologies would provide financial savings to individual consumers over the lifetime of the equipment of more than 25%. The Energy Foundation of USA recently said that "if California had not cut utility efficiency programmes by 56%, the present crisis could have been avoided". In India too there has been growing recognition of the importance of energy-efficiency in electricity sector; however, substantial efficiency gains are yet to be achieved. The following table gives likely energy conservation potential in various sectors.

Table 1 Energy conservation potential in India

Sector	Potential (%)
Economy wide potential	up to 23
Agriculture	up to 30
Industry	up to 25
Transport	up to 20

Source Planning Commission

What is DSM?

Demand side management options are those which involve actions on the demand of electricity beyond the customer's meter. In other words, DSM is the implementation of those measures that help the customers to use electricity more efficiently and in doing so reduce the customer's bill and the utility costs and its obligation to meet the requirement. DSM can be achieved through the following measures.

1 Load management, i.e shifting of load from high cost to lower cost periods. This can be done through rationing the electricity prices like higher prices

during the peak hours and confessional prices during off-peak hours, seasonal tariffs, etc The objective is to shift the load from peak to off-peak duration to smoothen the load curve, drawing greater benefits or capacity utilization from the existing facilities.

2. Improving the efficiency of electricity-consuming equipment of various end-use sectors. This approach can be termed as strategic conservation of electricity, regardless of the time of use.

3. Financial deterrents against misuse/non-productive use of power, e.g. through cost-reflective tariffs.

3 Barriers to energy-efficiency and DSM in India

There is little doubt that India's electric power sector could gain from the implementation of energy-efficiency and DSM programmes. In spite of these efforts, substantial efficiency gains are yet to be achieved. There are a number of technical, cost-related, institutional, and information-related barriers that have constrained the actual promotion and implementation of energy-efficiency and DSM in India. The absence of appropriate market conditions and government policies, lack of information, lack of consumer confidence in new technologies, capital scarcity, or simply a rather limited interest in energy costs and savings have all contributed to slowing the introduction of energy-efficient technologies. This is further constrained by the fact that often several parties share the costs and benefits of increased efficiency. An understanding of barriers to economic investment in efficiency is crucial to a successful DSM strategy. Some of these are described below.

(a) *Lack of awareness:* The main barrier to energy conservation is the lack of awareness by industry managers of the potential gains from improved efficiency. Industrial and commercial customers as well as government are yet to take into consideration factors such as tax credits, depreciation benefits, electricity price escalation, life cycle savings of the investment and the time release of money.

(b) *Lack of widespread education and training:* Lack of curriculum in educational institutions, shortage of widespread educational opportunities in energy management and conservation, and lack of trainers and auditors.

(c) *Economic and market distortions.* Irrational response to conservation measures because of inappropriate pricing and other market distortions, or socio-economic factors.

(d) *Lack of standardization and labelling of equipment/devices:* Slow rate of progress in achieving higher standards of energy consumption in equipment and appliances. There is a lack of initiative by the Indian industry to implement and follow national standards. It is felt that compliance to national standards or any other standards would definitely have an impact on the improvement of efficiency and energy consumption in respect of appliances and equipment.

(e) *Lack of financing:* The lack of credit and the inability to obtain financing for projects are strong deterrents to investments in energy-efficiency in India.

(f) *Lack of effective co-ordination:* In India, the lack of effective national-level co-ordination and promotion of energy conservation activities have been a major constraint to achieving energy-efficiency. There are multiple organisations that are associated in the activities of energy conservation. It would be appropriate to have a single organisation that would co-ordinate with other agencies.

(g) *Affordability of energy-efficient products:* Energy-efficient products are generally expensive and not affordable by a large section of the society and they are more sensitive to first time investment rather long-term gains.

(h) *Inadequate benefits to consumers:* Benefits offered by the utilities to the consumers in terms of time-of-day tariffs are not considered adequate to compensate the extra effort and inconvenience with off-peak utilization.

(i) *Unremunerative tariff:* This leads to misuse of electricity by the subsidized sectors also any reduction in energy consumption by the subsidizing sectors unfavorably affect the utilities.

(j) *Lack of consumer consciousness:* Wide acceptability of low cost inferior quality equipments such as pumps, motors, etc by agriculture consumers and small-scale industries.

(k) Absence of energy-efficient equipment in end-use sectors.

(l) Poor quality of power supply (voltage and frequency excursions) at times capable of alarming the user equipment.

In India private utilities are showing much interest in taking up DSM programmes. AECo. has implemented a DSM programme in the domestic sector in its supply area, and the results are very encouraging Similarly, Asian Electronics in association with Maharashtra State Electricity Board has installed capacitors to increase the PF (power factor) and increase the efficiency of the power-looms in Bhiwandi district. The benefits are shared by both as par their agreement The concept of ESCOs (energy service companies) is also gaining popularity. Under such schemes, investing company would share the profits due to increase in efficiency with the other party as par the agreement reached between them.

4 DSM applications: scope and potential in India

4.1 Industrial sector

The industrial sector accounts for about 45% of the total commercial energy used in the country and accounts for 31% of the total electricity consumption. The end-use of electricity in the industry can be categorized into four main groups: electric motors, lighting, electrolysis, and miscellaneous (like electro-heating). An indicative distribution of electricity by end-use in the industrial sector is shown in Figure 1 (World Bank Study Report 1991).

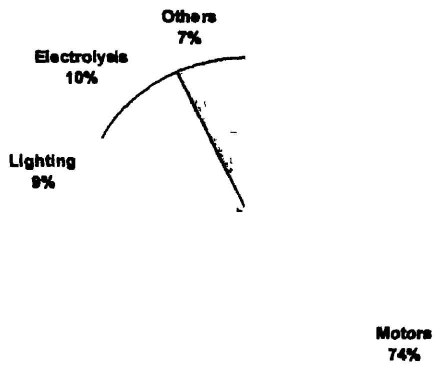

Figure 1 Distribution of electricity by enduse in industrial sector

Like in most countries, electric motors are by far the largest electricity consumers in India, accounting for more than 70% of the electricity consumption in industries. Overall there is a lack of awareness in industry regarding motor efficiency aspects. Numerous energy audits conducted by TERI and other agencies reveal that there is a large potential to save electrical energy by reducing electricity consumption in the above areas. Hence energy conservation in electric motors and lighting could be the key to DSM in industries.

Some of the estimates made by different study reports for energy conservation in energy-intensive industries and cost benefit of energy savings are given in Table 2.

Table 2 Scope for energy conservation in energy-intensive industries

Data	*Aluminum*	*Textile*	*Chlor-Alkali*	*Petro-chemicals*	*Fertilizer*	*Sugar*	*Paper*	*Cement*
Energy consumption (million cal)	30.1	52 5	20.0	5 8	112	100	26	67
Energy cost as a % of manufacturing cost	40	13	30-35	7	60	12	25	40
Scope of energy conservation (%)	15-20	20-25	15	15	10	20	20	10

Source Bureau of Industrial Cost and Pricing

4.1.1 *Electric motors*

Electric motors are the single largest electricity-using device in any industry. The importance of electric motors to the Indian industry is evident from the fact that motors account for more than 70% of all industrial electricity use. If further segmented, 3-phase squirrel cage induction motors dominate the scene, accounting for 70% of all electricity consumed in motors. DSM measures in the use of motors in industries should focus on two major areas, namely

1. Increased penetration of energy-efficient motors
2. Improved motor rewinding practices.

4.1.1.1 Energy-efficient motors

In India, motors are being manufactured in both organized and unorganized sectors. The efficiency of motors produced varies from one producer to another. Several manufactures have two ranges of motors – standard range and high-efficiency range. High-efficiency motors produced in India are 2%–5% more energy-efficient than those of standard efficiency motors. These motors cost 25%–35% more than standard efficiency motors and are not available for less than 10 HP rating due to limited demand. Energy-efficient motors account for a very small percentage of motor sales in India. Replacement of existing standard motor by new high-efficiency motor of the same rating is generally not viable. However, replacement of a failed motor by a high-efficiency motor is more economical than replacement by standard motor.

4.1.1.2 Improved motor rewinding practices

Failure of motors due to burnout of the stator windings is a common problem in industries due to overloading, under-voltage, and single phasing. Motor failure rate is typically about 10% annually in industries. Almost half of the population of motors is estimated to be of rewound motors. Since the rewinding cost of a motor ranges between 14% and 18% of the cost of a new motor, rewinding is a common practice in industries. However, poor motor rewinding practices lead to significant reduction in its efficiency. The reduction in efficiency varies with the size of motors and is about 10% in smaller motors (2–3 HP), 5% for medium-sized motors (5–10 HP), and 2%–3% for larger motors.

Although the increase in electricity consumption may appear small, especially for large motors, it is significant when viewed in the light of increase in annual electricity consumption. Hence proper rewinding of motors is extremely important, especially considering the high incidence of motor failures in industry.

A number of studies carried out in the past have estimated the savings of 100–119 TWh or 20%–25% of the 477 TWh of electricity demand projected for motors and drive system by 2009/2010 for India, if energy-efficient motors and driven system were to be adopted by the consumers. A technology menu for 'Efficient Energy Use for Motor Drive System' prepared by National Productivity Council, India, and Centre for Energy and Environmental Studies of Princeton University, USA, has estimated economics of thirteen energy-efficient improvement measures and their national savings analysis. These estimates are given in Annexes A and B.

4.1.2 Lighting

It is estimated that the share of electric lighting is about 13% of the total electricity consumption in all the sectors with a share of 9% in industrial sector In India, four types of lighting systems are widely used — incandescent, fluorescent, mercury vapour and sodium vapour. Table 3 shows that 80% of the incandescent energy use is in the domestic sector; over 90% of fluorescent energy use is in the industrial, commercial, and miscellaneous sectors; and over 60% of mercury and sodium lamp energy use is in the industrial sector.

Table 3 Lighting electricity use by sector and lamp type (TWh)

	Incandescent	*Fluorescent*	*Mercury*	*Sodium*
Domestic	7.4	0.3	0.0	0.0
Commercial and miscellaneous	1.2	6.2	0.1	0.1
Industrial	0.3	6.5	1.2	0.8
Public lighting	0.2	0.9	0.2	0.3
Total	9.1	13.9	1.5	1.2

There are several options for improving the energy-efficiency of lighting systems in the industrial sector namely slim line tubular fluorescent lamps, compact fluorescent lamps, HPSV (high pressure sodium vapour) lamps, metal halide lamps, voltage stabilizing electronic ballasts, high-performance reflectors, advanced lighting controls, and possibilities of retrofitting existing system with more efficient ones. Since colour rendition is not required in most areas of an industry, HPSV lamps present a good opportunity for energy conservation. In an energy audit conducted by TERI (1992) at a soda ash plant, the replacement of HPMV (high pressure mercury vapour) lamps by HPSV lamps had a payback period of 3.8 years.

Installation of efficient lighting has not yet taken place in any noticeable extent and the process continues to be hampered by a variety of factors including high cost of substitute arrangements, inadequate domestic production in some cases and a substantial tariff on their import, and, more importantly, because electricity for lighting use is too cheaply priced in most states of the country and there is little economic compulsion to spend on improved lighting systems, particularly for domestic and commercial users.

A World Bank Study Report (1991) estimates that by the year 2005 the total lighting consumption load would be 65.5 billion units, representing more than 30,000 MW by all types of consumers. The saving potential is 9,600 MW at end-use if the seven alternatives shown in Annex C are fully implemented.

Though such an order of savings is technically feasible, conventional lamps are not being widely replaced. Certainly the cost involved is a factor to reckon with. However, it has been demonstrated that the payback period with respect to most of these alternatives is quite short. Annex D shows the unit capital costs, conserved cost of energy, and payback period for the consumer for seven alternatives discussed above.

4.2 Commercial sector

Electricity is a major energy used in the commercial sector in India and approximately 60% electricity is consumed in lighting and 32% in space conditioning. Trends show that the electricity consumption in the commercial sector is increasing at a rate of 8.22%.

In most buildings, energy is consumed mainly for space conditioning, lighting, water heating and steam generation, vertical transportation, cooking, and other electrical appliances. The energy consumption rates and energy-use patterns in buildings vary considerably from one climate to another depending on the architectural design, the systems used, the operational and maintenance schedules, and the occupants' behaviour. In the past, most buildings were designed keeping aesthetics, functional requirements, and initial cost as major design factors. Omitting energy-efficiency as a design consideration has led to an oversizing of energy systems usually designed for peak conditions. However, the peak conditions seldom occur and the systems operate at the part-load or low efficiency most of the time. Therefore, there is a large potential for energy conservation and load reduction in buildings if buildings are designed using bio-climatic features, integrated with renewable energy technologies and use energy-efficient equipment. HVAC systems, heat pumps, load management systems and control, refrigeration systems/freezers, high-efficiency boilers, building control, insulation, window coating and films, power factor correction systems, and combined heat and power plants are some of the technologies for energy conservation. Energy audit studies conducted in several hotels, hospitals, and office buildings reveal techno-economic potential of energy saving of different activities, and is summarized in Table 4.

Table 4 Commercial sector potential savings (%) estimates

End use	*Energy-efficiency Measures*	*Technical potential savings estimate (%)*
Lighting	Delamping, low-wattage fluorescent lamps, compact fluorescent lamps, high-pressure sodium lamps, electronic ballasts, aluminum and silver film reflectors, daylight dimming, occupancy sensors, day lighting design in new buildings	20-50
Cooling	Heat pumps, high-efficiency chillers, chiller capacity modulation and downsizing, window treatments, radiant barriers, economizers, proper equipment operation and maintenance	≥15 without efficient lighting measures, 80 with efficient lighting measures, average is 30
Ventilation	Variable air volume systems, low-friction air distribution designs, energy-efficient motors, variable speed drives, heating, cooling, and lighting improvements, proper equipment operation and maintenance	50
Heating	Building shell improvements, window treatments, heat recovery, proper operation and maintenance, heat pumps integrated with water heating system	15-40
Refrigeration	Multiplex unequal parallel compressors, advanced compressor cycles, variable-speed compressor controls	15-40
Water heating	Low-flow devices, insulation, heat traps, heat pump water heaters, heat recovery systems, integrated heat pump systems (with space conditioning equipment)	40-60
Miscellaneous	High-efficiency office equipment high-efficiency motors and *adjustable speed drives for elevators and escalators*	10-30

4.3 Residential sector

In the domestic sector, lighting accounts for 35% and space conditioning for 30% of the total electricity consumed in the residential sector. Approximately 13% of the electricity consumed is in refrigerators and 8% in water heating. Only one per cent electricity is consumed in cooking. Trends in consumption pattern reveal that the electricity consumption is increasing at rate of 10.6% in residential sector. Major end uses are lighting fans, refrigerator, air-conditioner, washing machines, and water heaters. The potential for electricity saving in the residential sector is given in Table 5.

Table 5 Residential sector savings estimates

End use	Energy-efficiency Measures	Technical potential savings estimate (%)
Lighting	Compact fluorescent lamps	20-50
Cooling/ventilation	High-efficiency fan motors, whole house fans, programmable controllers	15-50
Refrigeration	High-efficiency refrigerators	15-40
Water-heating equipment	Efficient water heater tanks, increased tank insulation, low-flow devices thermal traps, heat pumps and solar water heaters	20-30 70
Electric ranges/ovens	Increased insulation, seals, improved heating elements, reflective pans, reduced thermal mass, reduced contact resistance	10-20
Miscellaneous equipment (television sets)	Solid state television sets that use efficient electronic devices	10

Utility supported DSM programme for lighting efficiency can be very attractive. A case study for the DVB (Delhi Vidyut Board) area shows a saving potential of about 35% (roughly 294 MW) in lighting only (see Annex E). In an energy conservation study carried out by TERI for a 5-star hotel, it was found that about 14% of the present energy consumption could be saved.

4.4 Agriculture sector

The electricity consumption in the agriculture sector in the early 1970s was 9%–10% of the total consumption; presently, its share is 30% (1999/2000). The sharp increase in electricity consumption is attributed to large-scale rural electrification programmes launched by the government at the same time. The expansion of supply in the rural areas led to an increase in the number of electrical pump sets by the farmers and thus the electricity consumption. Out of nearly 20 million pump sets in India, about 60% are driven by electric motors and the rest by diesel engines. Approximately 0 6 million electric pump sets are added every year. Inductive motive power and pumps characterize the agriculture load. Motors used by the farmers are generally of poor quality and efficiency. The initial high cost of energy-efficient motors and lack of knowledge about the long-term gains are the two major factors responsible for this.

The supply of electricity to the agriculture sector in many parts of the country is unmetered and is based on flat rate (HP basis) tariff, irrespective of the actual consumption. Thus, farmers are not concerned about the efficiency of motors, poor power factor, and high distribution losses.

4.4.1 Retrofitting in pump sets

The typical irrigation pump set in India consumes 4500 kWh in a year. A pilot study conducted by TERI (1996) estimates the saving potential in the range of 30% to 35% through major and minor retrofitting measures like

- substitution of the high friction GI/MS pipes by low friction PVC pipes
- use of low-resistance foot-valve
- improving the efficiency of the pump and the prime mover
- replacement of undersized pipes and fittings
- proper sizing of motors and pumps
- use of efficient coupling between motors and pumps.

The average efficiency before any rectification was found to be 27% and an increase of 7% in system efficiency of the pump sets was achieved with various measures. The average energy saving due to minor and major rectification was 277 and 310 kWh per HP per year respectively. The potential for improvement through pump rectification measures is given in Table 6.

Table 6 Saving potential in agriculture through retrofitting

Code	Scope of rectification	Reduction in energy consumption in % (kWh per pump per year)
R1	Low resistance foot-valve and low friction suction pipe of proper diameter	20%-25% (1000-1250 kWh)
R2	R1 + low friction delivery pipe	30%-35% (1500-1750 kWh)
R3	R2 + replace pump by one of higher efficiency	40%-45% (2000-250 kWh)
R4	R3 + replace motor by one of lower rating	5%- 60% (2500-3000 kWh)

Source Bulletin on Energy-efficiency

4.4.2 Power factor correction

Agriculture pump sets, which operate mostly at power factor of about 0.7 or below, result in high losses and, voltage drop and draws more reactive power. Power factor of 0.9 or more can reduce distribution losses significantly An adequate power factor can be obtained either by using good quality motors or providing reactive power compensation. The subject assumes considerable importance in the view of increase in the demand for agriculture pump sets.

A pilot project was undertaken by TERI with the help of MoP (Ministry of Power), GoI (Government of India) for the installation of LT Switched Capacitors on a sample of distribution transformers supplying power to agriculture pump sets in Punjab and Tamil Nadu. The findings of the study reveal that there is a scope for improving the power factor, which would result in less line losses.

The improvement in power factor would not only lower the losses but would also result in availability of more kVA capacity of transformer and reduction of kVAr requirement. Considering the economic benefits, the reactive power compensation by switched or fixed capacitors at consumer or sub-station end offer a or 'the most' cost-effective way of avoiding new generation capacity.

4.5 Other techniques for energy conservation

4.5.1 Load management

DSM through load shifting from peak to off-peak period has the potential to reduce the peak demand by over 50% and avoid the need for fresh capacity addition. Load management through segregation of agriculture load and supply of power only during the off-peak period; regrouping the farmers and supply of power though roster arrangement; and time-of-day tariff to provide incentive to industrial consumers to shift production during the off-peak period will substantially flatten the peak load and obviate the need for new capacity.

4.5.2 Time-of-use tariff as a DSM measure

TOU, or Time-of-use, tariffs are an important DSM measure and can encourage customers to shift their demand from peak to off-peak periods. This improves the efficacy of the system, helps them plan electricity use to reduce costs, reduces generation requirement due to shift of load, reduces the need for additional peak capacity, and increases load factor, and thereby system efficiencies. TOU tariff differs from other tariffs as in this case tariffs vary by the time of use of electricity. TOU rates are most often based on marginal cost of supplying power. Some utilities have moved from a simple energy rate to differential rates for different blocks of energy consumption. Large consumers in some utilities have tariffs that relate to time of consumption. Generally there exists two or more energy and/or demand rates, one for designated peak periods and the second for designated off-peak periods. Implementing this structure will require sophisticated metering systems, which can record demand and energy separately for peak and off-peak periods.

In the application of TOU pricing, considerable metering and other administrative costs are involved. Special meters are needed to record kW demand and kWh consumption during specified hours of the day. These meters cost substantially higher than the usual energy meters used for consumers who have a time-uniform rate Obviously, there is a trade-off involved in the selection of the consumer category to whom TOU pricing can be applied; the costs of metering (and allied expenses) have to be weighed against the (expected) benefits of TOU pricing by way of reduced peak demand of the system. The TOU pricing can be applied to large industrial consumers; due to two reasons: firstly, metering and associated costs of TOU pricing are likely to be a small proportion of the total electricity bill of the consumer concerned and secondly, there is greater possibility of shifting consumption pattern from peak to off-peak hours. Other categories, especially domestic and commercial, do not have significant potential for TOU application. Besides, the difference in the peak and off-peak hours will determine the consumers' willingness to change their consumption pattern and hence the potential for flattening the load curve. Many utilities around the world use peak load pricing. France was the first electric utility in the world to introduce (in 1956) a marginal cost-based tariff, which has been progressively modified and expended into what is currently the most sophisticated tariff structure. Many utilities in the US are currently involved in peak load pricing experiments in which load research data are being continuously collected to enable design of effective time-of-day rates.

4.5.3 Apparent energy pricing (kVAh)

Most consumers are unaware that the electricity bills that they pay has no bearing on their total consumption. This is because the existing tariff takes into consideration only one component of the total energy, namely 'average energy' whose measurement unit is kilowatt-hour (kWh). The other component, namely 'reactive energy' sneaks through the present meters and goes unmetered.

While active energy is responsible for doing work, developing torque or generating heat in load, reactive energy does no useful or productive work but contributes to the losses in the T&D (transmission and distribution lines) Since this undesired energy is unmetered, over the years, its consumption, as a percentage of the total energy consumption, has grown at an alarming rate. It is this wasteful consumption of reactive energy that is a major cause of high T&D losses, particularly in the power systems of developing countries. The reactive energy consumption has other detrimental side effects. It could lead to underloading of the generating units and inefficient utilization of T&D facilities including constraints in power evacuation. It is also responsible for much wider voltage fluctuations that are harmful and frequently damage electrical and electronic appliances

In the apparent tariff structure, consumers will be, therefore, motivated to choose electrical appliances that operate near unity PF so as to lower their total energy consumption and avail discount in their electric bills. For example, by operating a tubelight at unity PF instead of 0 5 PF, a consumer can obtain a 50% reduction in his corresponding bill. Brazil has modified its Electricity Act to implement Ampere-hour tariff. Though the implementation of the apparent energy tariff is simple, it should be pointed that a complete transition to the new tariff system would take 5–10 years. During the initial period of 5 years, the new tariff can be introduced as an optional tariff system that would co-exist with the current tariff structures. During this period, it is ideal to restrict the application of the new tariff to the following two sub-categories ·(1) old connections, which need meter replacement, and (2) new connections. The sites identified for the new total energy tariff must be fitted with apparent energy meters. After the initial 5 years, the apparent energy tariff could be made mandatory in high consumption LT (low-tension) categories such as LT industrial and commercial loads. The old active energy (kWh) meters must be replaced in a phased manner.

5 Review of legislation, policies, and programmes

The need for energy conservation was first recognized in the mid 70s following the first oil price shock. In 1974, a Fuel Efficiency team was set up comprising experts from the IOC (Indian Oil Corporation), NPC (National Productivity Council), DGTD (Directorate General for Technical Development) Recommendations of this team resulted in creation of PCRA (Petroleum Conservation Research Association) in 1975, with major oil companies, NPC, and Indian Institute for Petroleum as members.

The government of India set up an Inter-Ministerial Working Group on Energy Conservation in 1981. In 1983, the ABE (Advisory Board on Energy) was created for planning policies and programmes for the energy sector. In 1987, the government created the post of Adviser Energy Conservation, reporting directly to the Cabinet Secretary, to promote activities on energy conservation with greater focus. A separate cell for energy conservation was created in the Department of Power (now ministry) headed by a joint secretary.

The electro-technical wing of BIS (Bureau of Indian Standards) is responsible, among others, for setting energy-efficiency standards for various items of electricity consuming equipment. The BIS has published several Indian Standards on electrical equipment and appliances wherein the energy conservation parameters are incorporated by one or more of the following; (1) maximum power consumption, (2) minimum efficiency, and (3) maximum losses. In addition, there are other standards which takes into account the fuel and thermal efficiency of equipment and appliances. The NPC was one of the early organizations to cater the area of fuel efficiency and energy audits in the country.

The MoP is today the nodal agency responsible for coordinating energy activities in India. The EMC (Energy Management Centre) was created in 1989 as an autonomous organization under the Ministry of Power. The EMC is the executive agency responsible for implementing and monitoring energy conservation programs. The activities of the EMC include., (1) providing policy inputs to the governments on energy conservation; (2) promoting energy audits and providing recommendations to improve energy-efficiency; (3) organizing sector specific campaigns to create awareness; and (4) conducting training programmes for energy managers, supervisors, and other staff.

There is a large number of other organizations involved in the promotion of energy conservation efforts. The REC (Rural Electrification Corporation) promotes energy-efficiency in the agriculture sector. The existing programmes and policies of GoI can be broadly categorized into the following areas.

Tax incentives and duty concessions: GoI offers 100% depreciation in the first year and concessional excise/customs duty on specified energy conservation equipment.

Energy Audit Programme: The MoP, through the EMC earlier used to provide funds for energy audit studies in the industrial and commercial sectors. This scheme has been discontinued now.

Energy Audit Subsidy Scheme: Under this scheme, launched in 1988, assistance is available for preliminary and detailed energy audits, up to 50% of the cost of the energy audit, limited to the less of 100,000 rupees or 0.05% of the gross fixed assets of the company.

Equipment Finance for Energy Conservation Scheme: This scheme is being implemented by IDBI (Industrial Development Bank of India) jointly with ICICI and IFCI. Financing under this scheme is available in the form of term loans for the acquisition of energy conservation equipment by industrial undertakings which have been in operation for at least 5 years.

Electricity pump sets rectification programme: The SEBs (state electricity boards), with the support of MoP (Ministry of Power) and REC (Rural Electrification Corporation), undertakes demonstration projects for retrofitting agriculture pumpsets.

Setting efficiency standards for equipment: The BIS is responsible for setting standards for manufacturing, operational practices and related areas in the country Apart from standards, BIS has laid down guidelines for selection of energy-efficient equipment, guidelines for system design and proper matching of components, and codes of practice for proper equipment installation and maintenance. All products that comply with standards are given BIS certification.

6 Review of the Ninth Plan (1997-2002) activities

The Ninth Plan initiatives relating to energy conservation and DSM include strengthening of energy-efficiency programmes initiated during the earlier plans, rationalization of electricity tariff to various consumers, promotion of market-oriented efficiency measures like laying down of energy conservation standards, and labelling of equipment and gadgets. The Ninth Plan proposals also suggested the establishment of an institution for effective implementation of energy conservation programmes and to provide a mandate for market intervention. The targets set for the Ninth Plan targets are as under.

(i) On the supply side, thermal power stations should aim at a reduction of 10% in heat rate by the end of the Ninth Plan.

(ii) 1% reduction in T&D losses during each year of the Ninth Plan.

(iii) Bring down the auxiliary consumption at least by 1%, especially in the old thermal stations.

(iv) The demand side measures should be implemented through comprehensive programmes in each sector e.g. industrial, domestic, commercial, and agricultural. Each programme should provide for targeted savings, their quantification, and proper evaluation to ascertain the achievement.

(v) Compulsory annual energy audit of large consumers should be undertaken.

(vi) Time-of-day metering should be introduced initially for large power consumers for better load management. Its coverage should be slowly extended

No specific outlay was indicated in the Ninth Plan proposals for the DSM programmes, and it was suggested that funds may be arranged within the budget allocations for the central and state governments.

It was recommended that energy audits must be made mandatory for large consumers. The progress in this regard has not been encouraging. Only a few states have so far made energy audits compulsory for all consumers above a certain minimum load or consumption. Also, in the states where it was made compulsory, the progress has not been very satisfactory and was hindered by the absence of agencies capable of providing good services

To promote energy-efficiency the government has provided various incentives: 100% depreciation in the first year on specified energy-efficiency equipment and confessional excise/customs duty on notified energy conservation equipment.

Efforts in the area of improving the efficiency of pumpsets in the agriculture sector were not satisfactory. This sector still has a large potential for energy conservation by simple retrofitting measures as there are large number of agriculture pumpsets in operation having sub-optimum level of efficiencies. The lack of financing and awareness is recognized as one of the main reasons for failure in introducing efficient pumpsets. Very limited pilot projects have been undertaken in this sector.

In the domestic sector, the main thrust was on use of energy-efficient lighting and other energy saving devices. High initial cost of energy-efficient lighting is acting as a barrier in its large-scale adoption by the consumers.

In the industrial sector, after the motors, the second largest consumption of energy is in the energy intensive industries like iron & steel, cement, pulp and paper, fertilizer, chemicals, and sugar The specific energy consumption in these industries in India is still much higher than in other countries. The targets were proposed for improving the specific energy consumption; however, the achievement made in this regard could not be quantified due to lack of information.

The government has taken a number of steps to reduce theft of power and commercial losses. The states agreed to install meters at all the 11 kV feeders and monitor the energy flow in each feeder and fix clear accountability on the concerned officials. The progress on this aspect is encouraging and most of the states had plans to complete the task by the end of March 2001. Progress in states like Bihar, West Bengal, Uttar Pradesh, and some states in the North Eastern Region is slow and may take some more time.

The government has also initiated suitable measures to provide metered power supply to all the consumers by the end of December 2001. Some of the measures include carrying out energy audit and identifying the areas of losses, installation of tamper-proof static meters, and installation of time-of-day meters wherever possible The government is also extending financial support through the Power Finance Corporation at subsidized interest rate and through the APDP (Accelerated Power Development Programme) recently approved by the government.

The efforts of state governments to carry out energy audits have started giving some positive results by way of arriving at more realistic estimates of T&D losses. Most of the states, particularly reforming states, have started reporting higher T&D losses. After the implementation of reforms, Orissa, Andhra Pradesh, Haryana, Rajasthan, and Karnataka have reported higher losses, which were earlier partly camouflaged as agricultural consumption. At the all-India level, the reported T&D losses are estimated to be 24.7% during 1999/2000 However, the inter-state variations are wide. Orissa and Delhi report these losses around 45% - 48% whereas the losses are around 22%-26% in case of Bihar and Uttar Pradesh. In actual terms the T&D losses at the all-India level have increased from the level of 19.8% in 1992/93 to the level of 24.7% in 1999/2000

Most state governments have taken up the programme of installing meters at all the consumers end by the end of March 2002 and are making arrangements to procure the tamper-proof static meters. It may not be possible for the states to procure a large number of static meters from the market considering that the number of suppliers of such meters is limited. However, such massive efforts may be helpful in controlling the theft of power and commercial losses. Examples of specific programmes undertaken by some states in this regard indicate the possible benefits of energy-efficiency programmes as detailed below

1. A study conducted under the APEEP (Andhra Pradesh energy fffficiency project) funded by the DFID (Department for International Development) in the districts of Nalagonda, Mehboob Nagar, and Khammam, reveal possibilities of significant loss reduction in the distribution network as well as improvement in revenue collection. The study suugests the remedial measures like installation of static meters, extension of 11 kV feeders and augmentation of existing sub-stations.

2. The Tamil Nadu Electricity Board has taken several significant measures towards upgrading the sub-transmission & distribution system and achieved significant T&D loss reduction. The measures undertaken include segregation of the agricultural feeder to supply power only during off-peak period; installation of static meters on HT (high-tension) & LT (low-tension) consumers; penalty for low power factor; installation high accuracy meters on domestic consumers; and introduction of time-of-day tariff to induce industries to shift production to off-peak period. These measures have resulted in substantial revenue increase and also better load management.

3. All the HT consumers in Tamil Nadu are provided with static meters. This has facilitated the introduction of time-of-day tariff. At present, an extra charge of 20% over and above the normal HT tariff is levied for the consumption during morning and evening peak hours. For industries functioning with night shift alone a subsidized tariff is charged.

4. The government of West Bengal has taken up a pilot project with the financial assistance from the Ministry of Power to introduce time-of-day metering for HT consumers in few districts of the state.

The government has introduced the Energy Conservation Bill, 2000 in Parliament. The Bill has been framed keeping in view the fine balance needed between regulator and enabler of energy conservation and energy-efficiency measures among consumers and manufacturers. The Bill addresses a number of critical issues including laying down of energy conservation standards, labelling of appliances and gadgets, and mandatory energy audits of building complexes, setting up of the Bureau of Energy-efficiency, and establishment of Energy Conservation Fund at the federal and state level. Enactment of the Bill would facilitate the implementation of conservation measures

7 Strategies for the Tenth Plan (2002-2007)

There are many barriers to the adoption of energy conservation options in India. After reviewing the progress made in promoting efficient use of electricity by all sectors, existing and proposed government policies and programmes, lessons from other countries where such measures were successfully implemented, this sub-group would like to make following recommendations.

7.1 Establish an appropriate body for promoting energy conservation

It is strongly felt that to promote efficient and rational use of energy, there is an urgent need to establish an appropriate statutory body with requisite technical expertise by suitable legislation. The said body should have powers to make policy recommendations, formulate and facilitate implementation of pilot and demonstration projects, promote use of efficient equipment and devices, setting up norms for energy consumption for various equipments, enforce energy-efficiency standards in manufacturing equipment, devices, and appliances, take necessary steps to create awareness and disseminate information on efficient use of energy and its conservation, encourage financing of energy-efficiency projects by giving fiscal and financial incentives, establish a system of authorization of persons qualified to conduct and certify efficiency levels in industries, buildings, etc. The central and state government should be responsible for enforcing the energy efficiency measures. An appropriate body should evolve a pragmatic method of penalizing those violating the norms. The fixation of an amount to be paid as penalty should be based on economic principles.

Some of these functions like creating public awareness by companions, education and training, demonstration projects, and studies about the necessity of energy conservation were being undertaken by agencies like EMC, NPC, PCRA, associations of industries and chambers of commerce, and NGOs (Non-Governmental Organizations). However, the combined efforts by these players were not very effective in promoting energy conservation and use of efficient technologies. For a long time a need has been felt to establish a body that can promote and ensure effective implementation of various measures. Many developed countries have established similar organizations having representations from the government, industry, and other organizations. The Energy Conservation Center in Japan was established in 1978 just after the first oil crisis. The center is engaged in a wide range of activities, including research, public relations, publishing, education, training, examinations, technical development, consulting and information service, as the core of Japan's energy conservation promotion with the support and cooperation of the government agencies concerned and supporting members.

7.2 Create awareness, disseminate information and capacity building

The lack of public awareness about the potential gains from energy conservation is one of the major reasons for the limited adoption of energy-efficient technologies in various sectors. Awareness campaigns need to be stepped up. Training is also necessary for professionals, energy auditors, and management staff, those enforcing efficiency regulations and those providing technical assistance. Hence a major effort should be undertaken to create wider public awareness through information campaigns, education outreach programme, media advertising, media documentation, and involvement of corporate about the benefits of energy-efficiency.

Technical information on specialized subjects such as motor technology, application, sizing, selection, maintenance, rewinding, and repair should be prepared and disseminated. It is also necessary to establish a comprehensive database and develop manuals regarding efficient energy-utilization equipment and practices. This would help new and expanding industries to evaluate available technological options with regard to energy-efficiency. Technical training programmes on energy-efficient technologies and maintenance practices targeted for different plant levels will lead to greater adoption of efficient devices by the industry. More importance should be given to educate farmers in the country about the benefits of using efficient motors.

7.3 Make energy audits compulsory

Energy audits provide information on what measures the user should take to conserve electricity and other forms of energy, along with the anticipated cost, savings, and payback period. Energy audits must be made mandatory for medium and large industries having a certain minimum load or consumption. The concerned department of the state governments should prescribe this limit For large energy-intensive industries, the frequency for conducting such audits should be once in a three years This is because conducting a detailed energy audit takes time, and industry will require some time to implement the necessary measures recommended by them. The process of carrying out the energy audits in industries should be done in a phased manner, in line with capacity to enforce such audits by an appropriate body and capacity of industry to implement these.

Only qualified energy auditors should conduct such audits. The large industries should be asked to publish the findings/recommendations of such energy audits in their Annual Reports. Such audits should also be made compulsory for large commercial establishments. However, this can be voluntary for small industries and small dwellings Incentive schemes should be devised to give tax rebate to such consumers on implementation of suggestions made by the energy auditors.

Also make energy audits a precondition for businesses and industries to receive a loan from nationalized banks or financial institutions.

Some states have made energy audits mandatory for all consumers having load of 100 kVA and above; in Delhi, this limit is 500 kVA. It is necessary to fix these limits in a pragmatic manner so that as many energy-intensive consumer classes as possible are covered, with the numbers not becoming unmanageable.

The government should create a fund for providing financial assistance (partly or fully) for preliminary and detailed energy audits (refer section 7.18 page 29). The government should also tap the resources from international organizations, which are interested in implementing energy-efficiency projects in the country. The financial should also extend interest rebate, linked with the extent of energy savings.

7.4 Establish a system of authorization of persons qualified to conduct and certify efficiency levels in industries, buildings, etc.

An appropriate body must develop a system of authorization of persons/organizations/ and companies that have necessary technical skills to undertake meaningful energy audits. The said body should de-recognize person(s)/organization(s) and company (ies), if found giving false certificates, or certifying without properly conducting the energy audits. The list of such authorized energy auditors should be maintained and updated by the office and great care has to be taken to ensure that the empanelled energy auditors are those who can provide quality services.

7.5 Mandatory energy labelling for devices

Minimum energy-efficiency standards for electrical appliances and devices can help to expand the market for energy-efficient devices. Experience in the US suggests that manufacturers are motivated to adopt advanced technologies mainly because of the need to meet tough energy standards established by the government. In meeting these standards, manufacturers were also able to improve their competitiveness and reduce product cost. However, it is felt that implementation of any such norms/standards would be difficult as a large number of such appliances are manufactured in the unorganized sector in India. Even where energy-efficient standards are laid down, such standards are far too lenient to boost manufacturing of energy-efficient devices. Instead it will be appropriate to do 'energy labelling' progressively to cover all the devices, and in future should conform to certain minimum efficiency standards. In the US, several domestic appliances are required by law to display energy consumption labels. Some Asian countries like Korea, and Philippines have also initiated labelling programmes for major electric products.

Also, given the wide range of processes that exist today in industry, different vintages of technologies used, and different feedstocks and fuels in industrial sectors, establishing the norms for the each existing process may not be feasible. Attempts should be made to prescribe norms for all new industries, and the old industries should be made to first undertake a detailed energy audits and improve their specific energy consumption to the extent possible.

There are number of approved laboratories in India for testing and evaluation of equipment and appliances with regard to energy efficiency and energy consumption. The existing laboratories should be augmented and if need be, efforts may be made to set up new testing laboratories.

7.6 Support demonstration projects

Adoption and dissemination of energy-efficient technologies could be promoted through technology demonstration in various sectors. A number of new energy-efficient technologies are available in the international market, but the local industry is reluctant to adopt these because of high risks involved. In such cases, demonstration projects would help in 'market-seeding' and replication of the new technologies. Thus, it would be useful to demonstrate and monitor the performance of newer energy-efficient equipment either produced or imported, so as to promote energy efficiency. These demonstration projects could be set up with help from government, industries, and other agencies interested in promoting energy-efficiency.

7.7 Encourage participation of energy service companies

Lack of adequate resources and technical know-how are the two main constraints to the success of energy conservation efforts. An ESCO provides a package of technical and financial aid to a client with all necessary components to invest in an energy-efficiency project. The government should encourage promotion of ESCOs by providing necessary incentives.

7.8 Energy conservation codes for buildings

Energy conservation codes for new residential and commercial buildings should also be framed and made mandatory as there is a large scope for energy savings either by use of efficient lighting, proper space conditioning, or better architectural design.

7.9 Financial incentives

Financing of energy-efficient equipment is a major barrier to their adoption. This is because of (1) higher initial cost of energy-efficient equipment and (2) tendency of industries to minimize the first cost. For example, cost of energy-efficient motors is 20%-30% higher than standard motors in India. Higher prices lead to low demand, creating a vicious cycle and making it difficult for prices to fall Financial incentives in the form reduction in sales tax and abolishment of octroi on energy-efficient products and reduction in custom and excise duty on imported energy-efficient equipments can be considered. The incentives should be structured in such a way that makes them cost-effective to the organization offering these (i e. value of the resulting energy savings is greater than the cost of incentives).

In developed countries, especially in the US, DSM is promoted by utilities through low-cost financing, incentives, etc. However in India this does not appear to be feasible since utilities incur losses and do not have funds needed to promote DSM.

Multilateral development banks, industrial development banks, and private banks can play an important role in promoting energy-efficiency through concessional financing of energy-efficiency projects However, there are institutional constraints for large banks to finance smaller investments of a few lakh rupees. Here equipment suppliers have a major role to play. The manufacturers of energy-efficient devices should be encouraged to partly finance smaller DSM programmes since they directly gain from such an investment.

One area that needs greater attention is the agriculture sector, which accounts for 23% of the total electricity consumption. The agriculture sector has large scope for energy conservation by simple rectification measures as most of the pump sets in operation have sub-optimum efficiencies. Many SEBs with the support of MoP, REC, and other international agencies have undertaken several demonstration projects for retrofitting agriculture pump sets. In spite of such programmes being launched in the past, combined efforts have failed to make any noticeable impact on energy conservation. The government and other lending agencies offering loans for agriculture pump sets should ensure that all the new pumps, for which loans are taken, must fulfil certain minimum efficiency standards.

7.10 A suitable institutional set-up should be devised to collect and collate energy-efficiency statistics in different sectors and to monitor the progress/achievement of targets

It is important to collect and collate energy-efficiency statistics and consumption pattern as a function of type of consumer, process, region and other variables for different sectors. Such information can be utilized for identifying the areas where greater energy conservation efforts are required and to estimate the savings that could result from these. In India data on end-use electricity end users is either poor or non-existent. A central body with a networking of state level agencies should collect and collate such statistics. A suitable mechanism should be evolved for the same. The Energy Information Administration, a branch of the US Department of Energy, conducts regular national surveys of energy consumption in residential and commercial buildings in the US.

7.11 Support research and development for production of cost-effective devices

Government organizations, utilities, and corporate should support R&D of projects of private companies, universities, research laboratories or any other organization for cost-effective production of energy-efficient devices in the country.

7.12 Encourage differential pricing

Electricity rates by the utilities should be structured to give signals to the consumers that conservation and efficiency improvement would lead to savings on their monthly electricity bills. The tariffs should reflect the cost of providing the services to the consumers, particularly those getting subsidized electricity. A TOU tariff is an important DSM measure, which can encourage customers to shift their demand from peak to off-peak periods. This helps the consumer to reduce monthly bills (energy rates are also linked with time of use and are often lower for off-peak duration), reduces the need for additional peak capacity and increases load factors and thereby system efficiencies Such pricing can be more cost-effective for the large industrial consumers because (1) metering and associated costs of TOU pricing are likely to be a small proportion of their electricity bill and (2) there is greater possibility of shifting consumption pattern from peak to off-peak hours. Other categories, especially domestic and commercial, do not have significant potential for TOU application. Many utilities around the world are using peak load pricing. The state electricity regulatory commissions should encourage design of TOU tariffs in India.

7.13 Role of regulators

Electricity regulators can play an important role in energy conservation by designing tariff, that does not encourage misuse of electricity by the end-users. The commissions should also make mandatory the submission of a DSM programme by the utilities. By implementing DSM programmes, utilities can avoid new capital investments, provide cost savings for end-users, and create market pull for vendors and ESCOs. In India, certain customer classes (typically agricultural, municipal, and residential) pay rates that are below the utility's cost of service. In such cases, the utility has a financial incentive to promote and invest in end-use energy-efficiency as a way to reduce losses and to free power that can be sold to higher tariff consumers, thereby increasing revenues.

7.14 Ensure good quality of power supply

Power supply with voltage beyond the permissible limits affect the performance of the system. High voltage could damage the equipment connected. Low voltage supply results in more heat dissipation, hence more line losses besides burn out due to higher current drawals in the case of motors. Poor quality of power supply obligates manufacturers to produce and end-users to use equipments that can withstand large voltage fluctuations. However, such equipments is often less efficient than equipment designed to operate in narrower voltage range. Poor voltage power supply is said to be the main reason for CFL not lasting to their useful design life as they get damaged due to voltage fluctuations.

Therefore, regulatory commissions should ask utilities to ensure good quality of power supply Any savings on account of reduction in line losses will negate the need for additional new capacity. This would not only conserve the depleting natural resources but also cause less environmental pollution.

7.15 Promote decentralized generation in remote isolated areas

The power sector is presently dominated by coal-fired generation. The hydel contributes 22% and non-conventional energy sources around 1% of the total power generation T&D losses are a major cause of concern as on an average 20%–25% energy is lost in this process. For supplying power to remote areas where demand is marginal, it would be desirable to have mini and micro schemes to cater to the local requirements. This would not only supplement the generation but also reduce transmission losses. Local-level generation is possible particularly in hilly terrain in the form of run-off of the river and micro-hydel schemes and in urban areas through the use of various waste materials.

7.16 Use of solar water heater systems and other renewable energy appliances as a supplement to meet energy needs

The use of appliances based on renewable energy can supplement our demand for energy and negate the need for additional conventional power. The KERC (Karnataka Electricity Regulatory Commission), in its recent tariff order, has offered a rebate of paise 15 per kWh (earlier 5 paise per unit) on total monthly consumption to the consumers using solar water heater. The state governments should mobilize funds for promoting the use of renewable energy.

7.17 Targets for energy-savings during Tenth Plan (2002-2007)

Based on the energy saving potential in various sectors and type of end-use, and the pragmatic assumption of saving at least 20% of this during the Tenth Pan, Table 7 gives disposition of these energy savings.

Table 7 Tenth Plan Energy Saving Targets

End-use type		Targeted energy savings (MkWh)
Motors and drive systems (industry and agriculture sector)		80,000
Lighting (domestic, commercial and industrial sector)		10,000
Energy intensive industries		5000
	TOTAL	95,000

The total energy saving of about 95,000 at the consumption end will be equivalent to adding a new capacity of about 4000 MW assuming a projected T&D losses of 20.5% (as given in 16th EPS) and average all India PLF (plant load factor) of about 68%. Had the T&D losses being more than this projected, this capacity saving would be even much more than 4000 MW.

The estimated peak savings, however would be of the order of 2600 MW assuming that agriculture load will not contribute towards any significant peak reduction as agriculture load is generally supplied power during the off-peak hours in the country.

7.18 Market development of energy-efficient projects

One of the important reasons for poor market development of energy-efficient projects is the lack of financing. Since most energy-efficiency projects require low investment, entail high transactions cost, and are dispersed, they are not attractive to financial institutions.

Energy efficiency projects also do not generate a separate revenue stream that provides comfort to financial institutions to part escrow the same for repayment. Further, in the absence of a well-developed M&V (monitoring and verification) protocol, the financial institutions are not able to visualize distinct segregation of revenue resulting from energy saving. Many industries have the capacity to implement energy conservation measures on their own; however, their priorities in most of the sectors, is in favour of increasing the production capacity and thus profits rather than in undertaking energy conservation measures that would involve capital investments. Besides, there is also limited number of ESCOs in the country for providing technical and financial aid for energy-efficiency projects.

Unless these barriers are addressed, the existing success stories may not translate into market development. Therefore, India needs to urgently ensure financing of a large number of projects that will have demonstration effect and, thereafter, it is expected that the financial institutions would proactively support energy-efficiency projects and ESCOs would also emerge.

With this scenario in mind, evolving an appropriate financing mechanism for mobilizing and utilizing resources for undertaking energy-efficiency projects in the various states becomes extreme important. This mechanism for raising the finances should not be complex and must be easily implementable. At the same time, it is equally important at the same time to address the issues being faced by financial institutions in the country in lending the money for such projects either directly to a consumer or through ESCOs.

Strategies for raising funds

There should be a state-level funding mechanism for undertaking energy-efficiency projects in each state It is proposed that the energy efficiency fund should be raised through levy of a surcharge called "energy efficiency surcharge". This should be supplemented by finances obtained (1) from state or central government as a grant or loan on soft terms, (2) through a line of credit from multi-lateral agencies, and (3) through bilateral co-operation programmes

The amount collected from these sources should be managed by the respective state-level functionary and shall be utilized for the purpose it is meant for within the state only. It is estimated that to achieve the targeted energy savings, approximately 2500 crore rupees would be required during the Tenth Plan.

Energy-efficiency fund

The energy-efficiency fund shall be utilized for a variety of energy-efficiency measures including creation of awareness about the potential gains from energy conservation, development of the demonstration projects in various end-use sectors, and promotion of market penetration of energy-efficient equipment and devices. The fund from levying a small surcharge on the quantum of electricity sold to the consumers can be collected by the existing SEBs, transmission and distribution licensee or distribution licensee as the case may be depending upon the model of restructuring in the given state. If 1 paise/kWh is levied as energy-efficiency surcharge on electricity sales, this arrangement can help generate about 240 crore rupees annually at the present level of sales, even excluding the sales to agriculture consumers During the Tenth Plan this could raise about 1200 crore rupees assuming the same level of sales; however, in reality sales would certainly grow in future. This fund should be utilized for addressing various barriers to energy efficiency and improving the climate for energy efficiency. The actual investment requirements should come from the government, financial institutions and other sources.

Renewable/environmental protection fund

The renewable energy sector has the potential and the technological capabilities to contribute to our energy needs if adequate initial support measures are provided. To provide the necessary financial support to encourage energy from renewable sources, a fund can be created by levying a 'renewable/environmental protection' surcharge on the quantity of fossil fuels used for power generation.

It is estimated that a surcharge of 3 paise/kg of coal used for power generation can mobilize about 660 crore rupees assuming the present level of coal consumption. All power plants located within the state's geographical boundaries, irrespective of the ownership (SEBs/IPPs/PSUs/Mega Power Projects), will have to contribute towards this fund. The funds thus collected shall be passed on to an agency responsible for promotion and development of renewable-based power and environmental improvements beyond those required by legislation in the state. This fund should solely be used for encouraging purchase of renewable-based power. Increased share of renewable-based energy would have less health and environmental impacts and would be more sustainable. In the case of states that do not have potential for developing renewable energy sources, the amount collected under 'renewable/environmental fund' can be utilized for other energy-efficiency projects or for environmental improvements.

8 Development of power sector and growing environmental concerns

The power sector in India is poised for a big leap forward with projections of capacity addition of 1,00,000 MW in next 10 years. Supply side management has all along governed the power generation scenario. All the developmental projects use natural resources as raw material for various activities and as a sink for disposal of waste generated. This has resulted in stress on our natural resource base, which is showing signs of degradation in terms of polluted air, contaminated water, degraded forests, etc. It is, therefore, imperative that there is a shift in policy from generation to demand side management. In the following, an attempt has been made to highlight the interventions required on environmental issues.

8.1 Life cycle analysis

In India, environmental assessment of developmental projects is undertaken at individual project level with stress on conformity to various Acts and standards, which have been gazetted from time to time. An analysis carried out in coal-based power sector has revealed that energy is lost in various stages such as mining, transportation of coal, efficiency of boilers, transmission, etc. It is estimated that end-users get only 20% of the energy. For sustainable power development, it is necessary to ensure energy-efficiency at both ends, i.e. production and consumption. This would also ensure minimization of waste and optimal use of natural resources

8.2 Green accounting

For encouraging DSM and use of cleaner technologies, it would be necessary to introduce market-based philosophies. The GDP should reflect the use of natural resource base and the funds required for restoration of degraded eco-systems due to various activities. Introduction of green accounting will reflect actual price of power production and hence the need for energy conservation and efficiency. The analysis would also provide the required thrust on modernization and renovation of existing power plants for improvement of their plant load factor.

8.3 Establishment of industrial estates

Energy is a primary input for various industrial activities. The industries are presently established based on availability of raw material, water, land, and access to marketplaces. To conserve natural resources, it is necessary to use wastes or by-products from an industry as a raw material for the other. Establishment of industries, which compliment each other in a complex, would ensure waste minimization and energy-efficiency. Presently, the legislation on environmental impact assessment does not cover the concept of industrial estates. Introduction of this concept would be a step in the direction of energy conservation.

8.4 Emission base standards

The environmental acceptability of power plants in general and coal-based power stations in particular is primarily decided on its conformity to Acts such as Coastal Regulation Zone and Air and Water Act. The emphasis is on the expected resultant ambient air quality after the plant is made operational. The ambient air quality for various regions have been notified. To encourage use of better technology and restrictions on emissions, it would be desirable to introduce load-based standards, which in future may also help in emission trading.

Studies have to be made for fixing up limits for SO_x and NO_x for Indian power stations. High ash content in coal has made power stations, the major polluters. Major renovation or complete replacement is thus required to be done on aging pollution control systems. These have become completely inadequate to meet national standards. There is a need for establishing a system of collection of environmental data, and its analysis. None of the thermal utilities has installed Continuous Particulate Emission Monitoring System.

8.5 Strategic environmental assessment

There are a large number of Acts, both at the central and at state level in various segments of power generation such as mining, use of forest land, coastal zone regulation and air and water quality standards. These Acts are not rationalized and, therefore, in some cases, act at cross proposes. To manage the integrity of natural resource base and eco-systems, there is a need to undertake an exercise of impact analysis of policies, plans, and programmes in the power sector. The concept was introduced recently introduced in developed countries like Canada, the US and the UK. This exercise would enable better DSM too.

8.6 Demonstration projects

For sound decision-making, a reliable database is necessary. On environmental matters, long-term authenticated data are usually not available. There are very limited demonstration projects to highlight the benefits of various technologies concerning energy-efficiency, reduction of waste generation, non-conventional energy sources etc The establishment of such demonstration projects would help create awareness.

8.7 Participation and partnership

For better DSM an institutional mechanism needs to be evolved where participation and partnership is ensured between regulating agencies and stakeholders like entrepreneurs, public at large, and various utilities.

8.8 Fly ash handling and disposal

Fly ash, which is produced in power plants, can cause damage to aquatic life when disposed of in water. If not properly managed, fly ash also has the potential to contaminate the groundwater resources with traces of toxic metals that are present in it In India, the fly ash problem is of a huge magnitude: 80–100 million tonnes of fly ash is produced each year [a] because power grade coal contains over 40% ash (on an average). Gainful utilization of fly ash is limited to just over 10% as compared with 35%–100% in China, France, the Netherlands, and the Commonwealth of Independent States. It is estimated that the production of fly ash would increase from present level of 80–100 million tonnes to about 160 million tonnes a year by the year 2012.

Nearly 90% of the fly ash generated in India is disposed of using the lean slurry disposal system and pumped through pipes to an ash pond. This approach requires a huge quantity of water, creates wastelands, and causes serious health and other environmental hazards. There is likelihood of leaching of heavy metals and soluble salts percolating down through ash ponds. Air-borne ash around the ash pond and elsewhere is a serious health hazard as it can cause pulmonary diseases. In most cases, the system is an open one where the outflow of the slurry ponds into neighbouring water systems contaminates surface and ground water. Though the use of fly ash for mine filling near pit-head power plants, cement manufacturing, substitution, reclamation of low lying areas, construction of road and embankments, and making bricks has been demonstrated, its effective utilization is still quite low.

The following policy and fiscal measures would be necessary to promote the use of fly ash and as a consequence reduce the related health and environmental hazards.

8.8.1 Required policy interventions

1. Reduce ash content in coal (including coal for power) through promotion of selective mining; through regulations on ash content in coal.
2. Encourage use of fly ash by the cement and bricks industries, and for use as backfill in mines. In this regard, use of ash (in place of sand) in mine stowing of underground mines should be made mandatory for mine authorities (where power stations are located nearby)

8.8.2 Provide necessary incentives

The following equipment to be taken as deemed pollution control equipment (100% accelerated depreciation allowance, zero import duties).

- dry ash collection systems at power plants
- all equipment used to manufacture fly-ash-based products
- all equipment used for blending fly ash (at least 25% by weight) with other products, including counter-current mixers and cement grinding units

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[a] excluding the ash produced by burning of lignite in Tamil Nadu, Gujarat, and Rajasthan.

- Investment in other equipment for fly ash transportation, storage, and handling.
- Provide fiscal measures like subsidised rates of interest, excise duty & sales tax exemption on all equipment (used in ash products manufacturing) and ash based products as well.

8.8.3 *Other measures*

- Make it mandatory for coal mining companies to employ selective mining techniques, wherever applicable.
- Lay down specifications for different grades of fly ash for different uses in a move towards making fly ash a priced 'by-product' rather than an industrial waste.
- Make it mandatory for all government departments, including thermal power plants, to use fly-ash-based products such as PPC and bricks containing fly ash.
- Ban on use and manufacture of clay bricks around coal based power stations
- Lower interest rates on finance for housing and other projects that use fly-ash-based products such as PPC and fly-ash bricks.
- Set up commercial-scale technology demonstration centres for making bricks using fly ash — these centres could be set up by governmental organizations and operated by private entrepreneurs. The objective of such a centre would be to enable entrepreneurs to assess techno-commercial viability of the technology and to train prospective entrepreneurs in appropriate use of the technology with customization, wherever required.

Annex A

Economics of thirteen-energy-efficiency improvement measures (2009/10)

Efficiency improvement measure	Unit for analysis (output kW)	Energy savings (kWh/yr)	Peak demand savings (kW)	Initial cost (Rs)	Cost of saved peak capacity (Rs/kW)	Cost of saved electricity (Rs/kWh)
Retrofit measures						
Improved motor rewinding and maintenance	15	1738	0 86	3500	10150	0 86
Proper sizing with standard motor	15	2666	1 32	19425	36720	0 98
Proper sizing with high efficiency motor	15	3149	1 56	27000	43217	1 15
Proper sizing with multi-speed motor	22	15655	7 77	45000	14487	0 38
Installation of variable speed drive	45	69362	34 31	315000	22889	0 80
Optimize pumping system	15	13034	6 47	39100	15120	0 53
Optimize fan system	15	17379	8 62	52150	22680	0 80
Optimize compressor system	7	23645	11 73	106400	4813	0 17
Rectification of existing agricultural pumpsets	4	5236	1 30	2500	36371	0 17
Replacement and new installations						
Energy-efficient motor	15	1337	0 66	9650	36371	0 97
Multi speed motor	15	11091	5 50	11350	5158	0 14
Variable speed drive	37	40381	20 03	233000	42899	1 14
Optimize pumping system	15	13034	6 47	39100	15120	0 40
Optimize fan system	15	17379	8 62	52150	15120	0 40
Optimize compressor system	37	23645	11 73	106400	22680	0 60
High efficiency agricultural pumpsets	4	5236	2 60	10000	9625	0 26
New peaking power plant						---
Long run marginal cost						1 41 - 1 81
Short run marginal value						0 9 - 1.5

Source A technology menu for 'Efficient Energy Use for Motor Drive System' prepared by National Productivity Council, India and Centre for Energy and Environmental Studies, Princeton University, USA

Note. All figures are given in 1992 Rs values

Annex B

National savings analysis for efficiency improvement measures (2009/10), India

Efficiency improvement measure	(GWh)	(% of projected GWh demand in motors in industry + agriculture)
Retrofit measures		
Improved motor rewinding and maintenance	516	0.11
Proper sizing with standard motor	773	0.16
Proper sizing with high efficiency motor	808	0.17
Proper sizing with multi speed motor	1104	0.23
Installation of variable speed drive	3061	0.64
Optimize pumping system	600	0.13
Optimize fan system	281	0.06
Optimize compressor system	139	0.03
Rectification of existing agricultural pumpsets	2690	0.56
Replacement and new installations		
Energy-efficient motor	2538	0.53
Multi-speed motor	8211	1.72
Variable speed drive	18090	3.79
Optimize pumping system	5936	1.24
Optimize fan system	2615	0.55
Optimize compressor system	1299	0.27
High efficiency agricultural pumpsets	60616	12.70
Total	109278	22.89

Source A technology menu for 'Efficient Energy Use for Motor Drive System' prepared by National Productivity Council, India and

Centre for Energy and Environmental Studies, Princeton University, USA

Annex C

Efficiency improvements from improved lighting options

	Options	Unit reduction consumption (%)	Unit savings on consumption per year (kWh)	Peak savings (MW)
1	Screw in fluorescent tube	60	53	6,501
2.	Compact fluorescent tube	75	63	6,736
3	New fluorescent fixture	90	138	472
4	"TLD" fluorescent tubes replacing "LD"	10	14	854
5	Electronic ballasts fluorescent lamps	20	42	2,220
6	High power factor ballasts	33	--	2,768
7.	High pressure sodium lamps	40	360	314

Source World Bank Study Report, 1991

Annex D

Cost effectiveness of improved lighting options

	Options	Unit capital cost (Rs/kW)	Conserved cost of energy to the utility (Rs/kWh)	Feasible penetration, ie Extent or feasible replacement of effective fittings (%)/b	Payback period for the consumer (assuming electricity cost is Re 1 per kWh) (Years)
1.	Screw in fluorescent tube	2800	0 57	70	0 28
2.	Compact fluorescent tube	4000	0 94	35	0 63
3	New fluorescent fixture	3200	0 17	10	0 43
4	"TLD" fluorescent tubes replacing "LD" tubes	10	10	100	10
5.	Electronic ballasts in fluorescent lamps	10400	0 47	75	1 42
6	High power factor ballasts	1000	0 05	85	--
7.	High pressure sodium lamps	11400	0 52	80	0 57

Source. World Bank Study Report, 1991

Annex E

Savings potential in Delhi

Present load-2800 MW

Lighting load-30% 840 MW

Savings potential-35% 294 MW

Average billing rate-Rs 1 75 kWh

Annual load factor- 3

Annual billing-Rs 135 Crs

Let us assume present shortage can be partly offset by either investment in the new power plant or saving in the lighting demand

Option I	*Option II*
Generation- 300 MW	**Conservation-294 MW**
Investment-Rs 900 Crs	**Investment- Rs 441 Crs**
CRF-16%	*CRF-16%*
FC of energy-Rs 0 80/kWh	*Annual cost-Rs 70 Crs*
VC of energy-Rs 2 30/kWh	*Avoided loss-Rs 163 Crs*
TC of energy-Rs 3 87/ kWh	*Simple payback-5 months*
Loss/unit sale-Rs 2 12/ kWh	
Annual loss-Rs 163 Crs.	

Annex F

Success stories in DSM implementation

Canada's experience in energy conservation[1]

Various energy-efficiency improvements have helped Canada limit growth in its carbon dioxide emissions and thereby conserve natural resources. Energy-efficiency has been a key element of Canada's strategy for addressing climate change Using energy more efficiently is widely recognized as an effective way to reduce GHG emissions. Energy-efficiency also fosters the development of innovative technologies and processes that will lead to new economic opportunities for Canada. Energy-efficiency improvements–estimated through changes in energy intensity – have resulted in savings of about 4.4 billion dollars a year in energy costs. The OEE (Office of Energy-Efficiency) has a mandate to renew, strengthen, and expand Canada's commitment to energy-efficiency. Some of the measures being adopted are listed below.

- Minimum performance levels for more than 20 energy-using products that account for 65% of overall residential energy use. These regulations have greatly improved the energy-efficiency of new household appliances and equipment

- The CBIP (Commercial Building Incentive Program) has received 147 applications for funding to help offset the additional cost of designing more energy-efficient commercial buildings. To date NRCan (Natural Resources Canada) has committed 4.5 million dollars in incentives for design projects that meet the programme's requirements. Eight projects received funding in the start-up year of this three-year programme. Some designs submitted to CBIP are for buildings that, once constructed, will consume 50% less energy than if they were constructed under the Model National Energy Code of Buildings.

- More than 249 industrial companies representing about 75% of industrial energy use have been recruited as industrial energy innovators, thereby agreeing to adopt and achieve voluntary energy-efficiency targets.

- More than 400 fleets representing about 85,000 vehicles have registered with the FleetSmart Programme, which provides private-sector fleet managers with information, workshops, technical demonstrations, and training programmes on fuel-efficient practices for fleet vehicles.

- The federal government has made significant progress toward its own target of reducing greenhouse gas emissions from federal operations by at least

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[1] The state of energy-efficiency in Canada, Annual Report of the OEE (Office of Energy-efficiency), 1999

20% from 1990 levels by the year 2005. Emissions from federal operations are estimated to have declined by 16% between 1990 and 1997.

Energy-efficiency programmes of the OEE

The OEE manages 18 programmes aimed at moving the market toward improved energy-efficiency.

The ***Model National Energy Codes for Buildings and Houses*** aims to increase the energy-efficiency of new buildings and houses by specifying minimum requirements for energy use. The programme supports the implementation and adoption of the code by relevant authorities having jurisdiction over buildings and houses in regions across Canada.

The **R-2000 HOME Programme** encourages the construction and purchase of new, energy-efficient houses. Home builders volunteer to build to the R-200 standards, which exceeds the energy-efficiency level required by building codes and other regulations.

Reno$ense encourages owners of existing houses to improve the energy-efficiency of their homes when undertaking renovations or maintenance work.

EnerGuide for Houses is a national energy performance evaluation and labelling programme that encourages owners to improve the energy performance of their houses. The programme provides house owners with the facts needed to make informed decisions about energy-efficiency, whether they are making improvements to their existing house or buying a new one.

Under the authority of the Energy-efficiency Act, NRCan sets **Energy Performance Regulations** for certain types of energy-using equipment. Regulations eliminate the most inefficient energy-using products from the market.

Regulations under the Energy-Efficiency Act require that major household appliances display an **EnerGuide** label, which shows the yearly energy consumption rating of the appliance and positions it on a scale of the most and least comparable models available in a given year.

The **EnerGuide Heating, Ventilating and Air Conditioning (HVAC) Energy-efficiency Rating System** provides consumers with all the information needed to purchase energy-efficient home heating and air-conditioning products and provides contractors with the tools they need to increase sales of energy-efficient HVAC equipment.

The **Commercial Building Incentive Programme** provides financial incentives to incorporate energy-efficient technologies and practices into designs for new commercial, institutional, and multi-unit residential buildings.

The **Energy Innovators** and **Energy Innovators Plus** initiatives encourage commercial/institutional establishments and municipalities to voluntarily invest in energy-efficient equipment and adopt practices to reduce the operating costs of their facilities. Financial incentives may be available for retrofit pilot projects that can be replicated in other facilities.

Through the **Federal Buildings Initiative,** NRCan helps other federal government departments improve the energy-efficiency of their existing buildings and heating equipment.

The **Industrial Energy-efficiency Initiative** is a voluntary government–industry alliance that helps Canadian industry identify energy-efficiency potential, establish energy-efficiency targets, implement and manage programmes, report on progress, and celebrate accomplishments.

The **Motor Vehicle Fuel Efficiency Programme** encourages automobile manufacturers to produce vehicles that meet voluntary average fuel consumption targets for new cars, vans, and light-duty trucks.

Auto$mart is an information-based programme that encourages motorists to buy, drive, and maintain their vehicles in ways that reduce fuel consumption, save money, and benefit the environment.

EnerGuide for Vehicles is a voluntary initiative under which vehicle manufacturers attach an EnerGuide label to all new cars, vans, and light-duty trucks sold in Canada. The label indicates the vehicle's fuel consumption rating and estimated annual fuel costs and can be used by consumers to select the most fuel-efficient vehicle that meets their needs

FleetSmart provides private-sector fleet managers with information, workshops, technical demonstrations, and training programmes on fuel-efficient practices for fleet vehicles

FleetWise provides federal fleet managers with the information and tools needed to improve the operational efficiency of fleets, reduce greenhouse gas emissions from fleet operations, and accelerate the use of alternative transportation fuels.

The **Public Information Programme** increases Canadians' awareness of the environmental impact of energy use and encourages consumers to adopt energy-efficient practices and switch to alternative forms of energy. The programme produces and markets numerous publications and provides promotional products and marketing support, including exhibits, for all OEE initiatives.

The **NEUD (National Energy Use Database)** initiative supports the development of Canadian energy end-use data, knowledge and analytical capabilities. The NEUD also supports the collection of data on energy consumption at the end-use level, the characteristics of energy-using equipment and buildings, the behaviour of Canadian consumers toward energy use, and the adoption of energy-efficient technologies.

Experience of the US and other countries in DSM

There are many examples of outstanding DSM initiatives undertaken in the US. The programme launched by various utilities achieved a high participation rate along with energy savings at a lower cost than conventional approach of adding new supply capacity. The energy shocks of the early 1970s resulted in unprecedented increase in fuel prices and, as a result, the electricity rates also went up significantly This led to change in consumption pattern and prompted consumers to save electricity by utilizing it more economically. Higher prices forced utilities and customers to search for new energy-efficient technologies. The Pacific Gas & Electric and Tennessee Valley Authority began encouraging energy conservation in mid 1970s. The initial attention was given to energy audits and technical assistance to all the classes of consumers, providing soft or zero interest loans and rebate for purchasing energy-efficient equipment by all customer classes. Of these initiatives, the energy audits and financial incentives for commercial and industrial customers were found most economical and attractive Home energy audits were also conducted by Tennessee Valley Authority and this practice was made mandatory by Federal Residential Conservation Services. As the time progressed, DSM programmes also underwent change. Energy conservation by load management stared in the 1980s. The Table A gives a comparison of DSM options being adopted by some of the countries.

Table A DSM options adopted by developed countries

Country	**DSM initiatives**
Belgium	• Shift from oil to nuclear generation High voltage tariff • Wider acceptance of time-of-use tariff with three daily periods • 50% discount on demand charges to willing consumers • 30% to 40% rebate on demand charges for curtailment of the load at the time of peak Low voltage tariffs • Optional by-hourly rate with two daily periods • Interruptible tariffs for space and water heating Seasonal tariffs *Note* Load curve in Belgium is very flat during daytime and efforts are made to reduce day and night time differences and seasonal variations
Brazil	• Introduction of 'hour seasonal tariff' for large industrial customers Blue Tariff (applicable for high voltage (>69 kV) customers) • Demand and energy charges higher during peak hours

	Green tariff (applicable to medium voltage customers i.e 69 to 2 3 kV) • Different prices of energy • Purchase of surplus power from cogenerators/autoproduction Setting up PROCEL (Programmea National de Conservacao de Energia), an agency to promote efficient use of electricity to: • educate customers about energy savings • promote dissemination of adequate price signals • implement and develop energy saving programmes • research different market segments for planning and programme implementation • establish standards and to control the quality of more efficient DSM components and systems Time-of-use tariff. varying energy charges particularly for domestic subscribers. Industrial customers have to pay demand charges as well
Finland/France	Load management Valley filing, load shifting, peak clipping, and flexible load shape Introduction of time-of-use tariffs
Italy	Time-of-use tariffs

Source Demand-Side Management Planning by Clark W Gellings, PE and John H Chamberlin, published by the Fairmount Press, Inc , Lilburn, GA, USA, 1993

Ahmedabad Electricity Company's DSM Programme[2]

The concept of DSM is still not well accepted by Indian utilities. In spite of enormous saving potential, there has not been significant gains achieved from such efficiency measures by them. The private utilities are more proactive in undertaking and encouraging DSM projects than public sector undertakings.

AEC or Ahmedabad Electricity Company, a privately owned electric utility has undertaken and implemented various DSM measures with the help of Resource Management Associates, USA in its franchise area with a mix of industrial, commercial, and residential users and a small number of agriculture users. Realizing the significant potential for improving energy-efficiency, particularly in electricity utilization, AEC was identified as a demonstration site for a DSM programme under USAID funding, for a three-year Energy Management Consultation and Training project. The programmes under this project are listed below.

High-rise Building Water Pump Programme

In Ahmedabad, municipal water is supplied to residents only for few hours a day, which coincide partially with the utility's peak demand. Under is programme two water tanks were built. Water is pumped from lower tank to the upper tank and the upper tank provides a continuous water supply to residents. The results showed energy savings ranging from 22% to 65% and demand savings from 5% to 48%

Flour Mill Programme

This includes interventions such as maintenance of the motor and mill (2%–5% savings), capacitor installation (power factor improvement from 0.75 to 0.92), drive belt maintenance and conversion from V-belt to flat belt (1% to 12% savings), increasing mill speed, and installation of energy-efficient motors. By improving the power factor, the reactive power demand was reduced by 1000 kVA.

Time-of-use Meters Programme

Time-of-use meters were installed for a sample of high-tension customers to shift their peak load from peak to off-peak duration.

Motor Programme

The purpose of this programme was to support the penetration of energy-efficient motors and effective motor specification and maintenance practices in Ahmedabad.

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[2] Source Paper titled "Demand Side Management at Ahmedabad Electricity Company", Resource Management Associates, Inc Madison, Wisconsin, USA, 1997.

High-tension Industrial Energy Audits

The high-tension industrial consumers account for 25% of AEC's total system peak demand. The purpose of the energy audit programme was to improve the energy-efficiency and reduce demand. Based on 22 preliminary audits and 5 detailed audits, it was estimated that with appropriate energy-efficiency measures, 2.4 million kWh can be saved monthly and customer demand can be reduced by about 8 MW.

Lessons that can be drawn

- Customer acceptance is the first requirement for successful DSM programme implementation.
- A major barrier experienced by AEC in the full-scale implementation of strategies was lack of sufficient funding
- AEC's DSM experience can be replicated at other utilities throughout India.
- DSM implementation, particularly in India, is a slow process and requires joint efforts by the utilities, consumers, Governmen, and manufactures, as well as financial institutions. Each of these groups must be educated and convinced of DSM's benefits
- DSM programme concepts, programme details, and DSM technologies developed in the West often need to the modified for India.
- Encourage creation of ESCOs.
- Given the Indian social and business climate, standard customer or dealer rebate programmes are unlikely to be successful.

Annex G

Terms of Reference of the Sub-Group

(i) To review the energy audit and energy conservation systems prevalent in various utilities and to recommend necessary changes to make them more effective.

(ii) To look into the first and foremost aspect of energy conservation i.e. legislation, and to suggest suitable legislative measures in areas wherever required.

(iii) To suggest an institutional set up at the apex level which may be named the Energy Conservation Authority with necessary legislative backing.

(iv) To review the energy conservation programme and demand side measures implemented during the Ninth Plan.

(v) To formulate a strategy and action plan for Tenth Plan by setting appropriate targets for Demand Side Management and Sustainable Development of the Power Sector.

(vi) To suggest energy conservation measures for improving specific electricity consumption for different end-use sectors and load levelling through tariff and other measures.

(vii) To identify such areas where legislation is not required, but energy conservation may be implemented through promotional incentives.

(viii) To review the problems in ash disposal, pollution, and other environmental issues